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Spanish bottom trawl spring survey “*Fletán Ártico 2015*” in the Slope of Svalbard (ICES Division IIb2)

By

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Abstract

The “*Fletán Ártico 2015*” spring survey is a continuation of the Spanish bottom trawl survey series started in 1997 on the slope of Svalbard (ICES IIb2) using commercial vessels. The present survey was carried out from the 19th of June to the 10th of July, 2015 on board a Spanish freezer trawler using a bottom trawl gear. There were 81 valid hauls in which Greenland halibut was clearly the predominant species (Catch per unit effort [CPUE] = 2,758.1 kg/hr; abundance index = 155,333 (‘000) individuals; and biomass index = 150,385 tons). In the frame of the spring surveys, the present survey shows a positive trend in these indices, but such values are lower than the ones obtained from the autumn surveys. The latitudinal and bathymetric distributions of the species were similar to those observed in previous years. Population structure was also quite similar to those described previously, with a predominance of males. Modal length was 46 cm for males and 48 cm for females. Mature Greenland halibut individuals were dominant in the catches. Cod (1,120.6 kg), redfish (734.7 kg) and roughhead grenadier (460.8 kg), were the three main accompanying species in terms of weight. When compared to the Greenland halibut, the accompanying species show very low CPUE values and very low abundance and biomass indices. By-catches of Vulnerable Marine Ecosystems (VMEs) indicator species were generally absent or low. Only in two hauls the sea pen by-catches exceeded the NAFO threshold for “significant research vessel trawl sea pen catches”.

Key words: Abundance, biomass, by-catch, deep-water bottom trawl, Greenland halibut, North-east Arctic, Svalbard.

1. Background and objectives of the Spanish bottom trawl survey in the slope of Svalbard

The "*Fletán Ártico 2015*" survey is the continuation of the Spanish bottom trawl survey series using factory trawlers (Table 1.1) started in 1997 (Paz & Durán Muñoz, 1997) by the *Instituto Español de Oceanografía* (IEO), focused on the Greenland halibut in the slope of Svalbard (ICES IIB2). Investigations on Greenland halibut in this area had already been done in 1995 during an experimental fishing campaign (Durán Muñoz & Paz, 1996).

The main aim of the "*Fletán Ártico*" survey series was to obtain abundance/biomass indices and data on the distribution and biology of the Greenland halibut on the slope of Svalbard. Complementary data on accompanying species was also collected.

The results from these studies enable (i) the provision of updated information to the ICES Arctic Fisheries Working Group - AFWG (Hallfredsson *et al.*, 2013; Paz & Casas, 2013; Durán Muñoz *et al.*, 2014) which contributes to advice on sustainable management of deep-water fisheries resources and (ii) continuity of the Spanish fisheries studies in the Fisheries Protection Zone around Svalbard (Moleenar, 2012) within the framework of the Paris Treaty (1920).

The 2015 survey was originally planned as a "*spring*" campaign, but due to logistical issues had to be delayed to the late spring - early summer time.

Table 1.1 Spanish investigations on Greenland halibut on the slope of Svalbard since 1995, using factory trawlers.

Nº	Survey series	Year	Vessel	Number of hauls	Quarter	Dates	Institution
1	Pilot experimental fishing	1995	*	657**	1	6 Jun- 8 Jul	IEO
1	Fletán Ártico	1997	EHKC	156	2	26 Sept - 27 Oct	IEO
2	Fletán Ártico	1998	EFJS	148	2	1 - 24 Oct	IEO
3	Fletán Ártico	1999	EFJS	133	2	4 - 29 Oct	IEO
4	Fletán Ártico	2000	EHIM	147	2	2 - 31 Oct	IEO
5	Fletán Ártico	2001	EHIM	146	2	2 - 28 Oct	IEO
6	Fletán Ártico	2002	EHIM	155	2	4 - 30 Oct	IEO
7	Fletán Ártico	2003	EHIM	150	2	2 - 29 Oct	IEO
8	Fletán Ártico	2004	EHIM	149	2	2 - 28 Oct	IEO
9	Fletán Ártico	2005	EHIM	144	2	3 - 28 Oct	IEO
10	Fletán Ártico	2008	EDKX EBVD	84 74	1 2	2 - 15 May 1 - 15 Oct	AZTI
11	Fletán Ártico	2009	EDKW	91	1	21 Apr - 8 May	AZTI
12	Fletán Ártico	2010	EBVD	73	2	5 - 20 Oct	AZTI
13	Fletán Ártico	2011	EDKX	114	1	1 - 19 Jun	AZTI
14	Fletán Ártico	2012	EBVD	49	2	15 Sep - 1 Oct	AZTI
15	Fletán Ártico	2013	EBVD	63	2	4 - 18 Sept	IEO
16	Fletán Ártico	2014	EBVD	57	2	2 - 19 Sept	IEO
17	Fletán Ártico	2015	EDKW	81	1	19 Jun-10 Jul	IEO

EBVD: Eirado do Costal; EDKX: Nuevo Virgen de la Barca; EDKW: Nuevo Virgen de Lodairo; EFJS: Puente Pereiras Cuatro; EHIM: Garoya Segundo; EHKC: Playa de Sartaxens; * Six factory trawlers; ** Svalbard and Barents Sea (ICES Divs. Ia+IIB).

1: "*Spring*" survey; 2: "*Autumn*" survey;

2. Material and methods

2.1 Study area

As in previous surveys, the study area (Figure 2.1.1) is located on the western slope of Svalbard, between 73° 30' N and 80° 00' N (North-east Arctic, ICES Division IIb2). The zone lies within the Fisheries Protection Zone around Svalbard, at depth strata between 500-1,500 m approx.

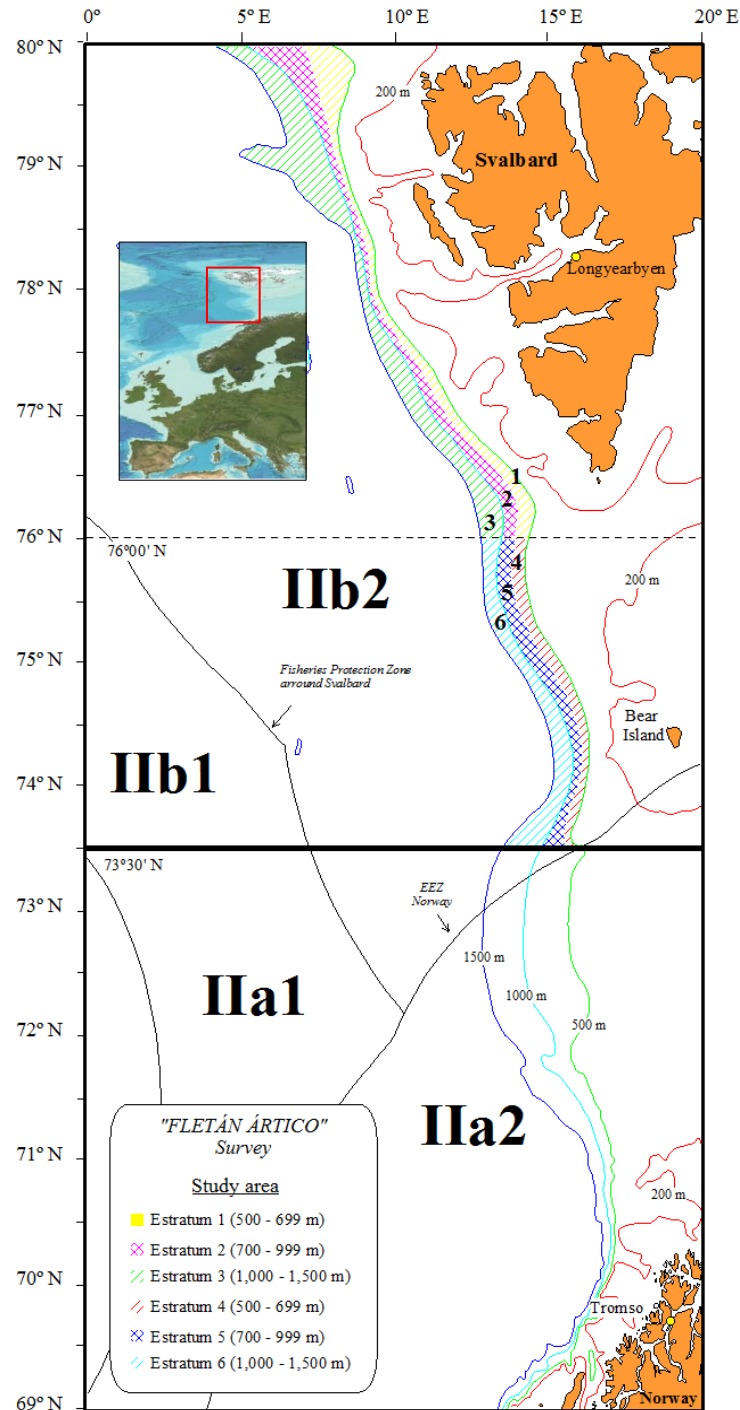


Figure 2.1.1 Study area of the *FLETÁN ÁRTICO* Spanish bottom trawl survey series.

2.2 Characteristics of the vessel

The 2015 survey was conducted using the freezer trawler *B/C Nuevo Virgen de Lodairo* (Table 1.1). This vessel is specialized in the North-east arctic cod fishery. The technical characteristics of this trawler are presented in Table 2.2.1.

Table 2.2.1 Characteristics of the vessel used. Spanish bottom trawl spring survey “*FLETÁN ÁRTICO 2015*”. Source: Captain & Census of Spanish fishing fleet

Nationality:	Spain
Call sign:	EDKW
Overall length (metres):	56.20
Mean draught (metres):	4.62
Net tonnage (NT):	291.32
Propulsion & Power:	Diesel oil engine; 2,555 HP
Year of entry into service:	1988
Registered Port & Number:	Vigo (Spain) - 3ª VI-5-9973
Crew:	27
Echo sounders:	<i>Simrad ES60</i>
Net/trawl sensors:	<i>Scanmar</i>
Weighing scales:	<i>Scanvaegt / Marel</i>

2.3 Characteristics of the fishing gear

A bottom trawl gear type “*Alfredo Morenot - No5 modified*” was used during the survey. The technical characteristics of the gear used in 2015 are presented in Table 2.3.1. Net and rock hopper diagrams provided by the Captain are shown in Figure 2.3.1 and 2.3.2 respectively. This gear is different to the one used during the 2014 “*autumn*” survey.

Tabla 2.3.1 Characteristics of the fishing gear. Spanish bottom trawl spring survey “*FLETÁN ÁRTICO 2015*”. Source: Captain.

Headline:	37.5 m
Ground gear :	21 m
Type:	Rock hopper <ul style="list-style-type: none">• Mid section: rubber disks (21”) and rubber spacers (8”x 8”) + chain connector• Side section: rubber disks (21”) and rubber spacers (8” x 8”) + chain connector
Floats:	56 floats x 4.7 kg each
Codend:	145 mm mesh size
Liner:	40 mm mesh size
Shorting grid:	NO
Bridles:	Steel wire (28 mm). 220 m
Doors:	<i>Injector - Cobra</i> (6.0 m ² . 2,600 kg)

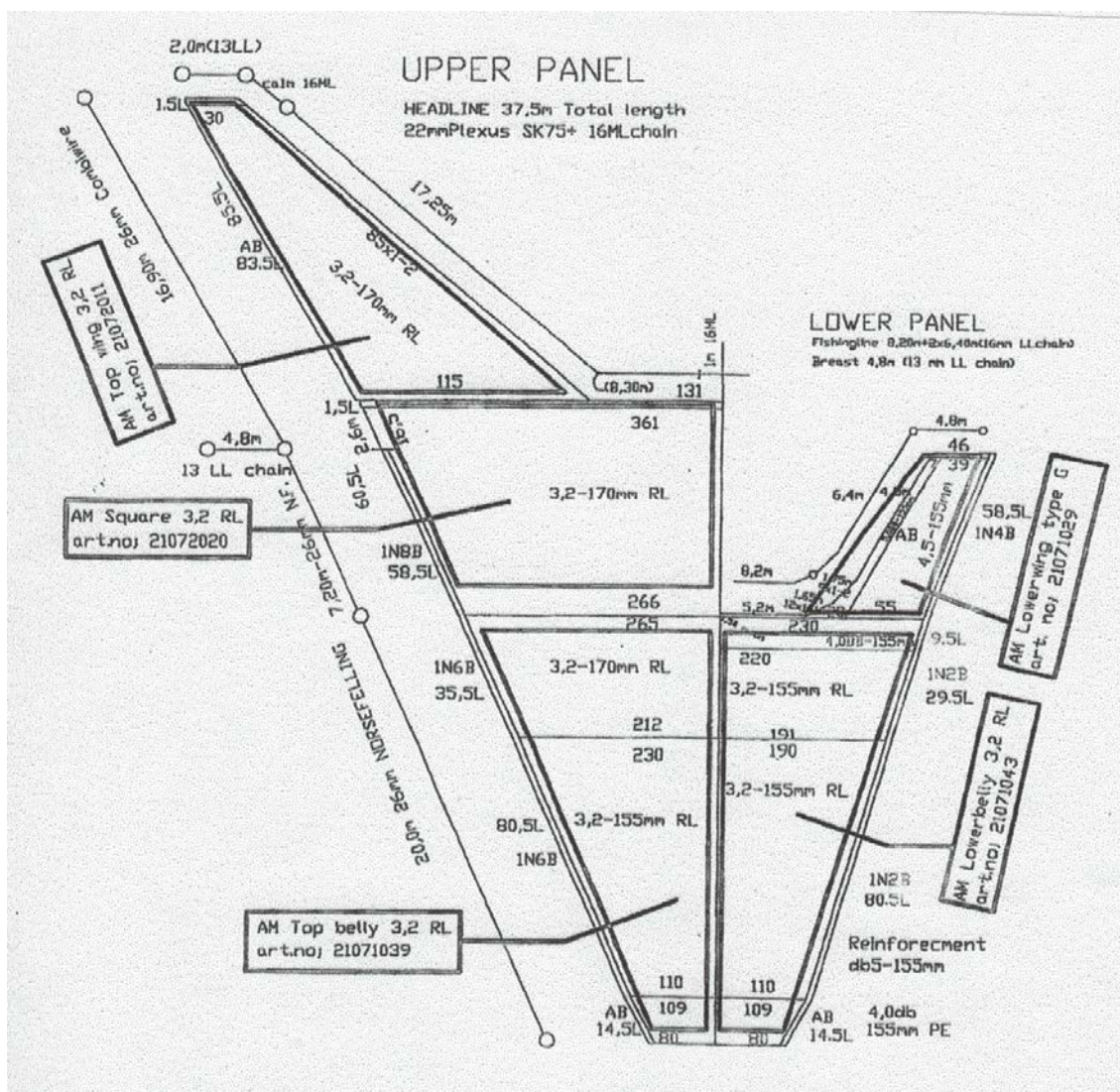


Figure 2.3.1 Net diagram. Spanish bottom trawl survey “FLETÁN ÁRTICO 2015”. Source: Captain.

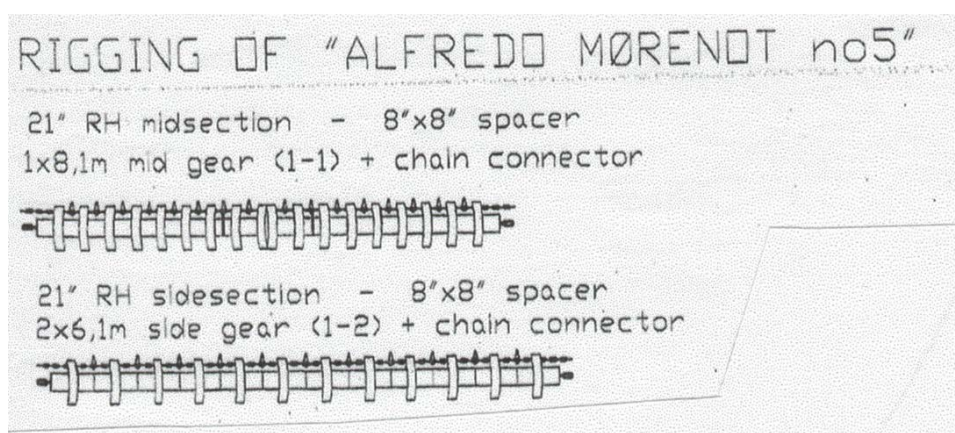


Figure 2.3.2 Rock hopper diagram. Spanish bottom trawl spring survey “FLETÁN ÁRTICO 2015”. Source: Captain.

2.4 Survey dates, incidences, methodology and data analysis

The 2015 survey was carried out from the 19th of June to the 10th of July, 2015 (port of call: Tromsø, Norway). Sampling took place between the 20th of June and the 8th of July, 2015.

The 21th of June there was a temporary interruption of the fishing activities to sail and collect spare parts (deep-water floats) from other vessel, in order to replace the damaged floats of the fishing gear.

The Norwegian Fisheries Inspection Services conducted an inspection visit during the survey (25th of June, 2015).

A total of 81 valid bottom trawl hauls were carried out. The location of the trawls is presented in Figure 2.4.1 and the haul characteristics are shown in Annex I.

The stratification designed by Norway in 1994 was used for the sampling scheme. Table 2.4.1 shows latitude and depth range limits for each stratum, as well as the surface area and the number of valid hauls conducted during the 2015 survey.

Table 2.4.1 Survey stratification and number of valid hauls by stratum. Spanish bottom trawl spring survey “FLETÁN ÁRTICO 2015”.

Strata	Latitude (N)	Depth (m)	Area (~nautical miles ²)	Number of valid hauls
1	76° 00' - 80° 00'	500- 699	702	14
2	76° 00' - 80° 00'	700- 999	1,263	14
3	76° 00' - 80° 00'	1,000-1,500	2,693	4
4	73° 30' - 76° 00'	500- 699	488	22
5	73° 30' - 76° 00'	700- 999	761	21
6	73° 30' - 76° 00'	1,000-1,500	1,672	6
Total				81

The effective duration of each haul was 30 minutes. *Scanmar* net/door sensors ensured that the fishing gear was properly configured at the bottom, besides providing information on the main geometry of the net and the distance between doors.

Catches were sorted and weighted by species/taxa. Fish and invertebrates were identified at the lowest possible taxonomical level using available literature. Length frequencies of Greenland halibut and the principal accompanying species were obtained by taking random samples (pre-anal length in the case of grenadiers; total length in the case of the remaining species). Other biological data of the main fish species were also obtained. Greenland halibut otoliths were collected and stomach contents were noted.

The standardised catch dataset (catch per 30 minute haul) was integrated within a GIS (Qgis). Regional bathymetric contours were obtained from the GEBCO database (General Bathymetric Chart of the Oceans). Abundance and biomass were estimated using the swept area method (Basterrestxea *et al.*, 2013).

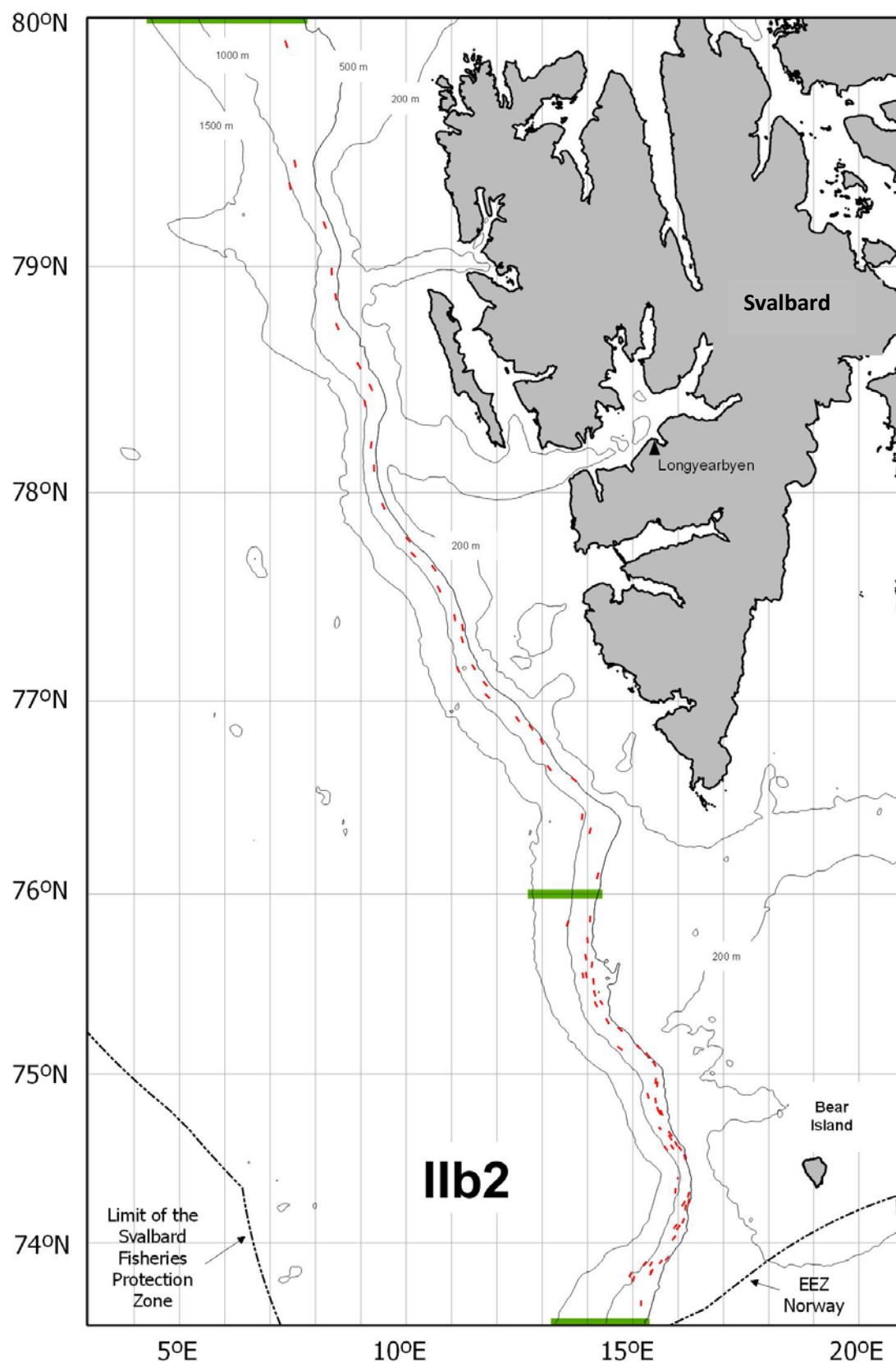


Figure 2.4.1 Location of the trawls performed during the Spanish bottom trawl spring survey “*FLETÁN ÁRTICO 2015*”.

3. Results

3.1 Catch composition

The pie chart in Figure 3.1.1 shows the percentage composition of catches by weight. Greenland halibut was clearly predominant in the catches (96.6 % live weight). All other fish species pooled accounted for 3.1 % of weight, while the pooled invertebrates represented 0.3 % of the catches.

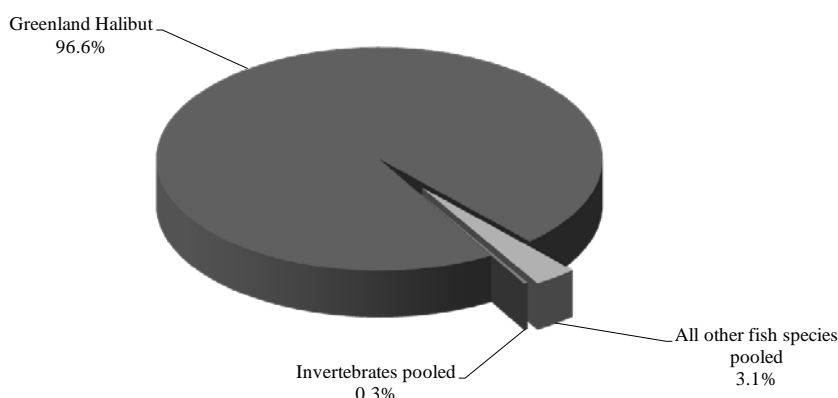


Figure 3.1.1 Pie chart showing the percentage composition of catches by weight. Spanish bottom trawl spring survey “FLETAN ÁRTICO 2015”.

Greenland halibut was the principal species caught (111,425.3 kg), showing the highest CPUE. Cod (1,120.6 kg), redfish (734.7 kg) and roughhead grenadier (460.8 kg), were the three main accompanying species in terms of weight (Table 3.1.1). Annex II shows the catches (kg) of main fish species by haul (30 minute hauls).

Table 3.1.1 Percentage of presence in the trawls [Presence (%)], total catch in live weight [Catch (kg)] and catch per unit of effort [CPUE (kg/hr)] of main species/taxa. Spanish bottom trawl spring survey “FLETAN ÁRTICO 2015”.

Species/taxa	Presence (%)	Catch (kg)	CPUE (kg/hr)
Greenland halibut (<i>R. hippoglossoides</i>)	100	111,425.3	2,758.1
Cod (<i>G. morhua</i>)	44	1,120.6	27.7
Redfish (<i>Sebastes</i> sp)	62	734.7	18.2
Roughhead grenadier (<i>M. berglax</i>)	75	460.8	11.4
Arctic skate (<i>A. hyperborea</i>)	60	374.0	9.3
Wolffish (<i>A. denticulatus</i>)	32	359.3	8.9
Blue whiting (<i>M. poutassou</i>)	60	269.2	6.7
Eelpout (<i>L. esmarkii</i>)	83	115.3	2.9
Skate (<i>B. spinicauda</i>)	25	83.5	2.1
Other fish pooled (Other pisces)	89	103.8	2.6
Sponges (Porifera)	44	124.0	3.1
Echinoderms (Echinodermata)	79	108.9	2.7
Molluscs (Mollusca)	58	52.3	1.3
Cnidarians (Cnidaria)	70	26.5	0.7
Crustaceans (Crustacea)	81	24.3	0.6
Other invertebrates pooled (Other invertebrata)	67	0.8	< 0.1

3.2 Greenland halibut distribution patterns

Figure 3.2.1 shows the standardised catches of Greenland halibut by depth and haul (30 minute hauls). The most important catches were recorded at depths between 600 and 750 meters. Catches were scarce in the hauls conducted at depths greater than 850 m.

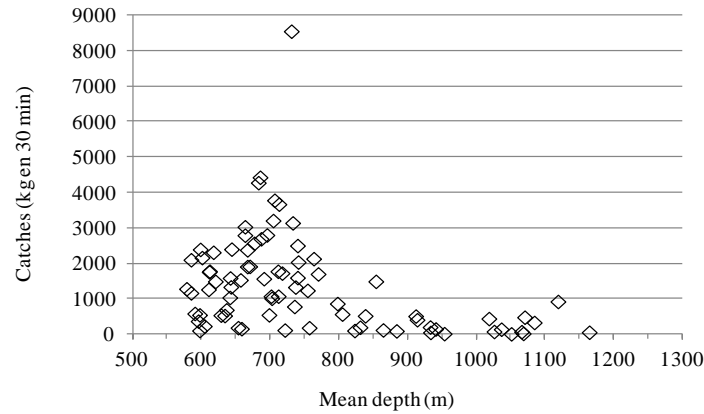


Figure 3.2.1 Greenland halibut catches in relation to depth, haul by haul (30 min hauls). Spanish bottom trawl spring survey “*FLETAN ÁRTICO 2015*”.

Greenland halibut was observed to be widely distributed in the study area and was present in 100% of the trawls (Table 3.1.1). Figure 3.2.2 provides a map of the study area and the distribution of standardised catches (kg) of Greenland Halibut by 30 minute hauls. Besides depth, latitude also seems to be another factor that influences the abundance of Greenland halibut on the Slope of Svalbard in June-July. The abundance of the species increased as latitude decreased: generally, hauls carried out south of 75°30'N show higher values than the northern hauls.

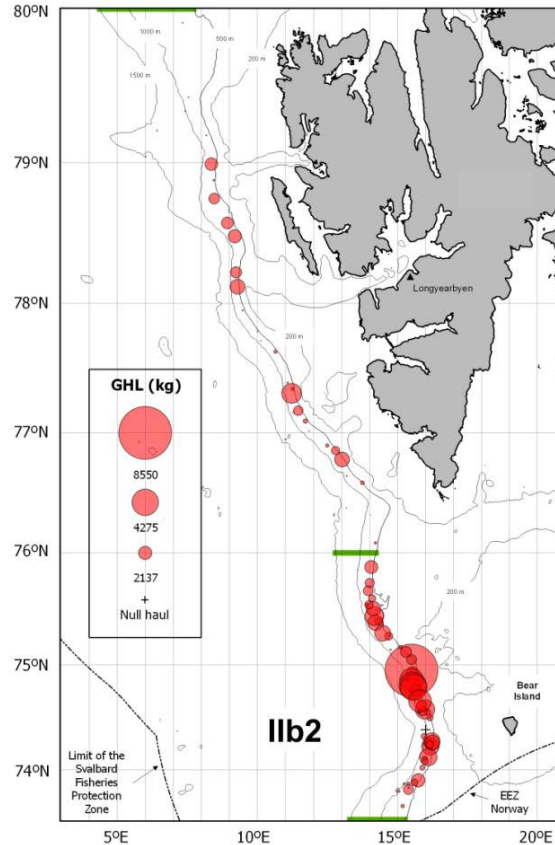


Figure 3.2.2 Map of the study area showing the distribution of standardized weight (kg) per set (30 min hauls) of Greenland Halibut. Spanish bottom trawl spring survey “*FLETAN ÁRTICO 2015*”.

The *boxplot* of Figure 3.2.3 shows Greenland halibut catches by stratum. Deeper strata; 3 and 6, show lower concentrations of Greenland halibut while the shallower strata in the south; 4 and 5, show the highest concentrations. Variability was observed to be higher in the strata with high concentrations.

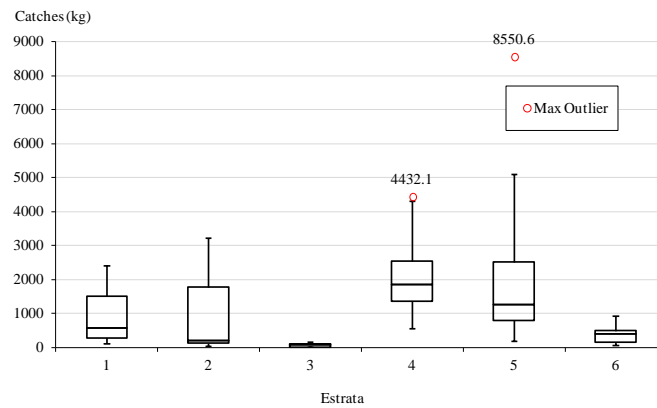


Figure 3.2.3 Greenland halibut catches by stratum. Spanish bottom trawl spring survey “FLETAN ÁRTICO 2015”.

3.3 Greenland halibut relative abundance and biomass

The estimated abundance recorded in the present survey was 155,333 (‘000) individuals and the estimated biomass reached 150,385 tons (Table 3.3.1).

Table 3.3.1 Abundance (‘000) and biomass (ton) of Greenland halibut. Spanish bottom trawl spring survey “FLETAN ÁRTICO 2015”.

Estrata	Area (nm ²)	No of hauls	Catch (number)	Catch (kg)	Swept area (nm ²)	Abundance (‘000)	Biomass (ton)
1	702	14	13,820	13,034.4	0.468	20,716	19,539
2	1,263	14	15,156	12,336.2	0.472	40,582	33,030
3	2,693	4	323	279.9	0.133	6,557	5,682
4	488	22	34,058	44,819.9	0.743	22,378	29,449
5	761	21	39,512	38,606.6	0.685	43,904	42,897
6	1,672	6	2,516	2,348.3	0.198	21,198	19,787
Total	7,579	81	105,385	111,425.3	2.699	155,333	150,385

The values estimated in the 2015 survey show an increase in both indices when compared with the spring surveys carried out previously (Figure 3.3.1), but these values are lower than the ones obtained from the autumn surveys.

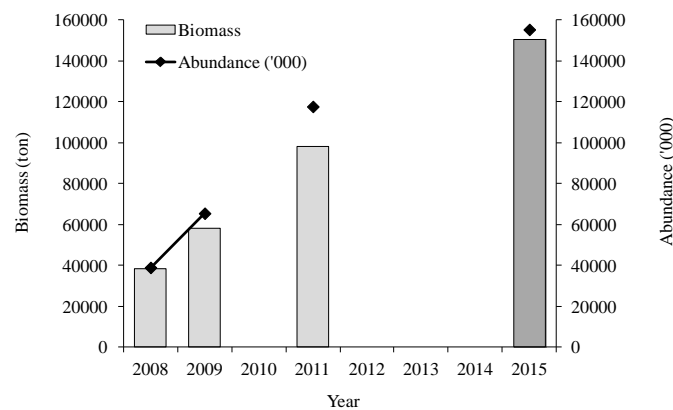


Figure 3.3.1 Greenland halibut biomass and abundance. Comparison between the Spanish spring surveys “FLETAN ÁRTICO”. (No spring surveys were conducted in 2010 and from 2012 to 2014).

3.4 Greenland halibut length distribution

The length structure of the Greenland halibut population (Figure 3.4.1) is observed to be quite similar to the one described in previous survey (Duran Muñoz *et al.*, 2014). The length range for both sexes combined ranged from 27 cm to 106 cm. The proportion of males was higher just like in previous cruises (72% of males vs. 28% of females). Modal length was 46 cm for males and 48 cm for females.

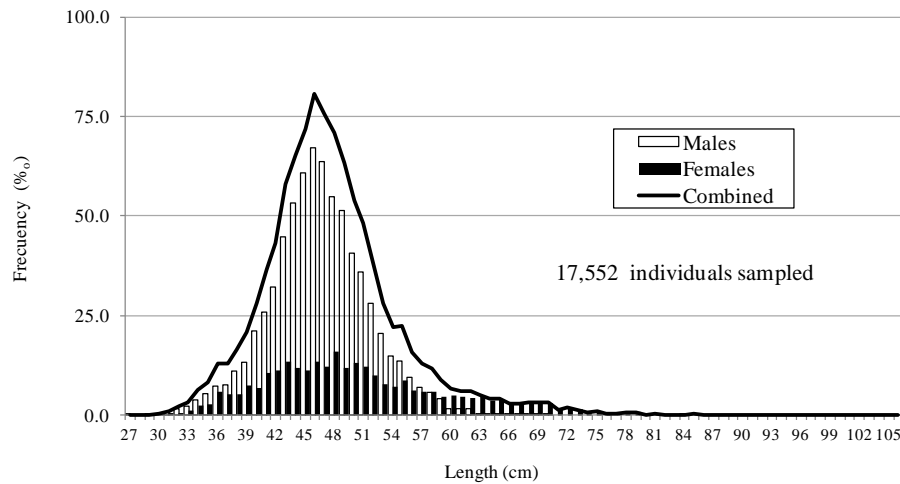


Figure 3.4.1 Greenland halibut length distribution. Spanish bottom trawl spring survey “FLETAN ÁRTICO 2015”.

3.5 Greenland halibut length-weight relationship

Figure 3.5.1 shows the Greenland halibut length – weight relationship: separated by sexes, and combined.

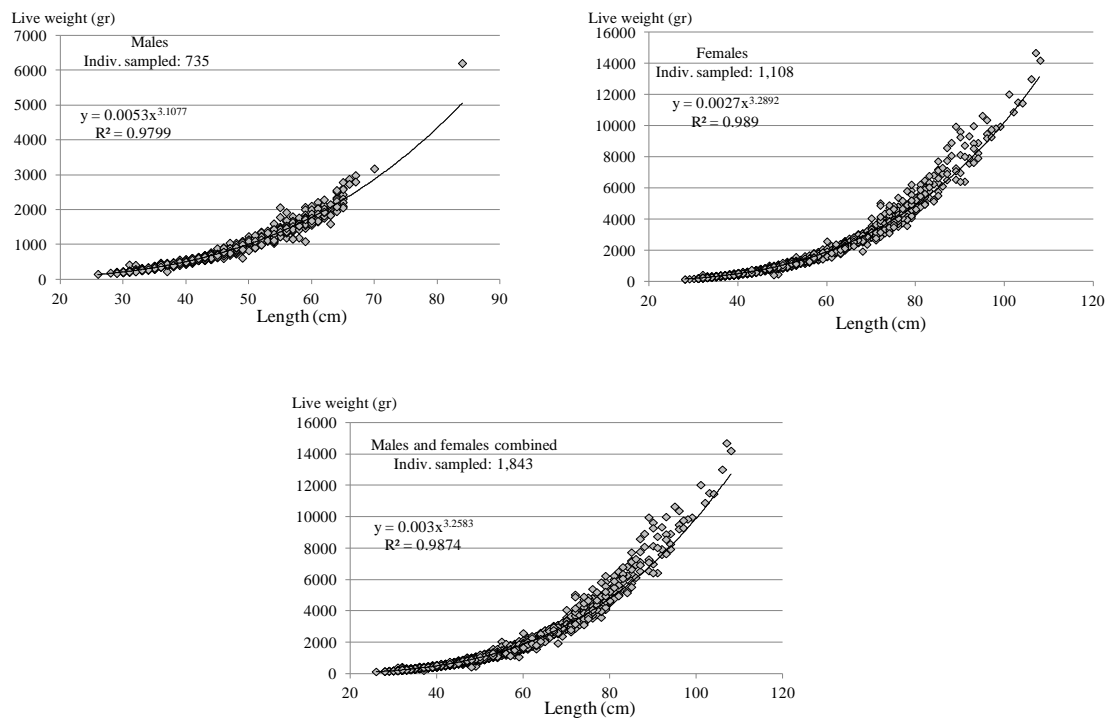


Figure 3.5.1 Greenland halibut length – weight relationship. Spanish bottom trawl spring survey “FLETAN ÁRTICO 2015”.

3.6 Observations on feeding activity of Greenland halibut and principal accompanying species

Greenland halibut shows a low level of feeding intensity (FI) in the study area in June-July, with FI values lower than the other principal accompanying species (Table 3.6.1).

Table 3.6.1 Total number of individuals sampled and feeding intensity, FI (%), of main species. Spanish bottom trawl spring survey “FLETAN ÁRTICO 2015”.

	<i>R. hippoglossoides</i>		<i>G. morhua</i>		<i>M. berglax</i>		<i>Sebastes</i> sp	
	Males	Females	Males	Females	Males	Females	Males	Females
Total indiv.	734	1,103	102	116	143	161	73	44
FI (%)	11.2	15.1	80.4	77.6	58.0	62.7	21.9	15.9

Figure 3.6.1 shows the level of feeding intensity of main species, by stratum. Greenland halibut feeding intensity level appears to be more related with depth than with latitude: FI is higher in the deeper strata, 3 and 6. Cod presented higher FI values north to 76°N than in the southern strata, particularly in a depth range from 700 to 999 m (stratum 2). In the case of routhead grenadier the FI level is little influenced by latitude, meanwhile in the case of redfish, no differences by depth or latitude are observed.

Greenland halibut usually shows low feeding intensity independent of the geographical area and seasonality. The current results corresponding to spring and the results obtained in 2014 corresponding to autumn, indicate slightly feeding increased in autumn, but difference was minimal between the two seasons. The behavior was similar in both sexes. Feeding activity increases slightly as individuals grow and it also increased slightly during sexual maturation, although the lack of data of individuals in spawning and post-spawning stages does not allow assessing the feeding pattern regard to the annual reproductive cycle.

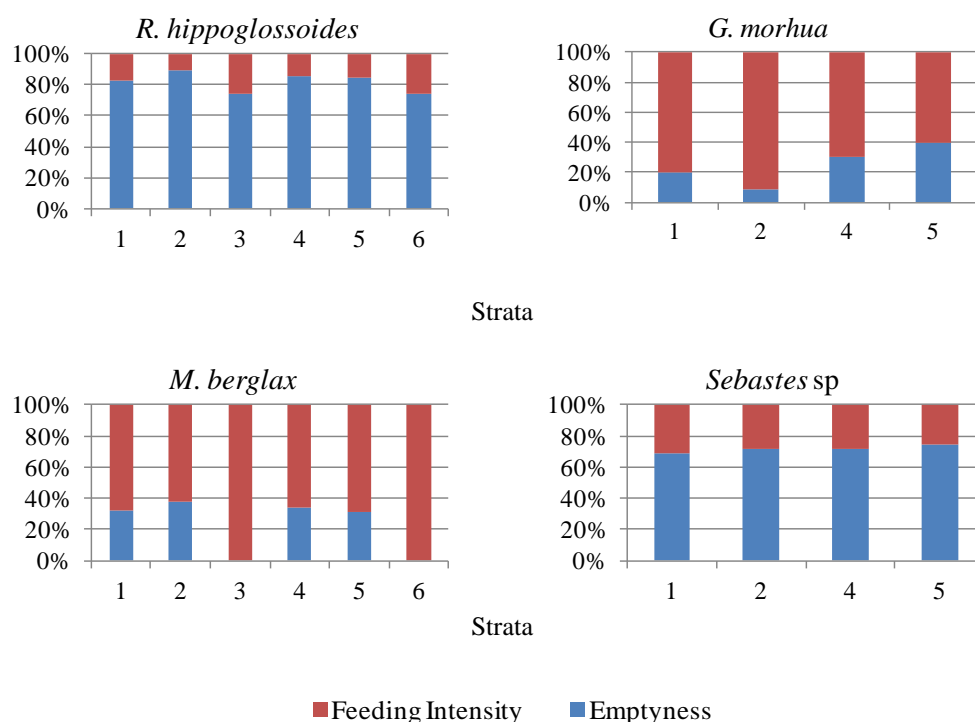


Figure 3.6.1 Feeding intensity of main species, by stratum. Spanish bottom trawl spring survey “FLETAN ÁRTICO 2015”.

3.7 Preliminary observations on maturity of Greenland halibut

The data on maturity of Greenland halibut were analysed based on visual examination of gonads (macroscopic). One of the problems of this method is that the subjectivity in the observations may lead to misclassifications of the reproductive status of the fish. Fish were classified as immature or mature. A maturity scales were used to do it, where the first stage (juvenile/immature) is defined as immature and all the others as matures (females: inactive, developing, spawning and post spawning; males: developing, spawning and post spawning). The percentages of mature individuals by length and sex are presented in Figure 3.7.1. The estimated L_{50} value for males was 36.7 cm and 44.6 cm for females. There is a predominance of mature fish.

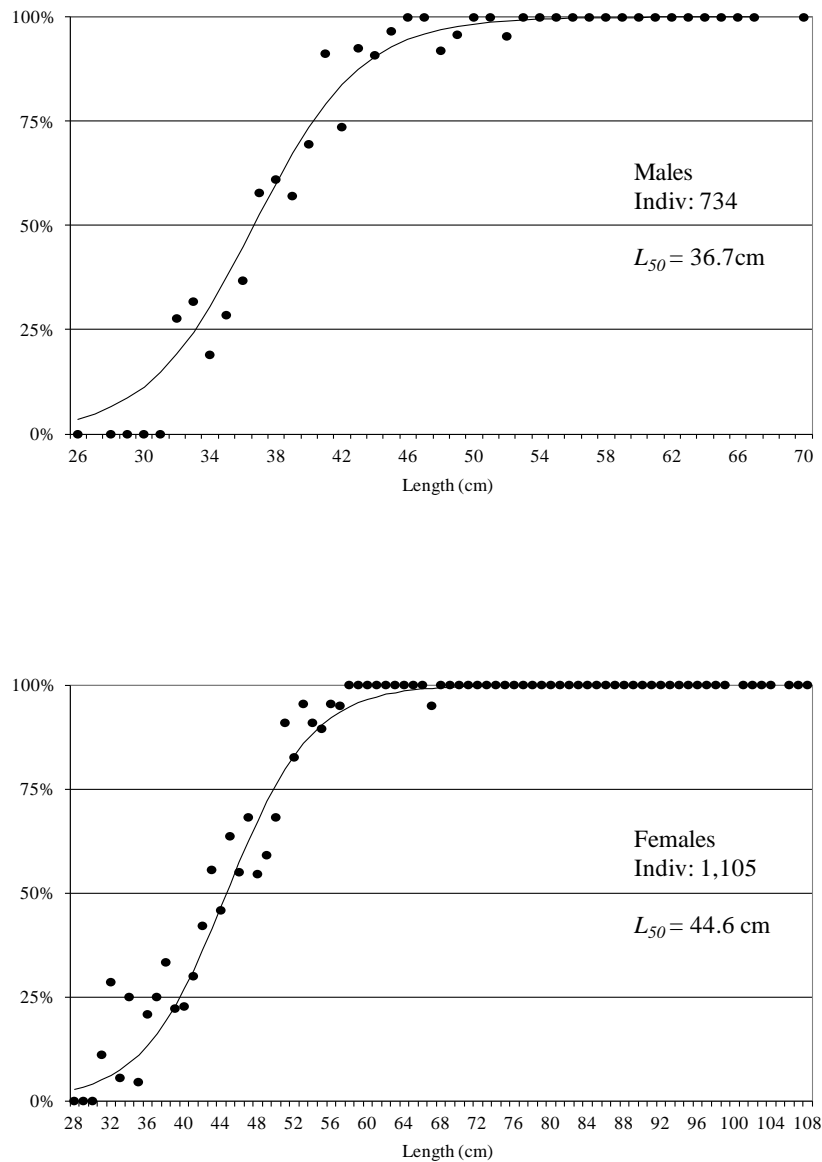


Figure 3.7.1 Percentages of mature Greenland halibut by length and sex. Spanish bottom trawl spring survey “*FLETAN ÁRTICO 2015*”. Preliminary.

3.8 Distribution patterns of the principal by-catch species

Figure 3.8.1 shows maps of the standardised catches by haul (30 minute hauls) for the main by-catch species. None of them presents a clear latitudinal distribution pattern. As in the 2014 survey, the abundance of roughhead grenadier, redfish and blue whiting apparently increased with a decrease of latitude.

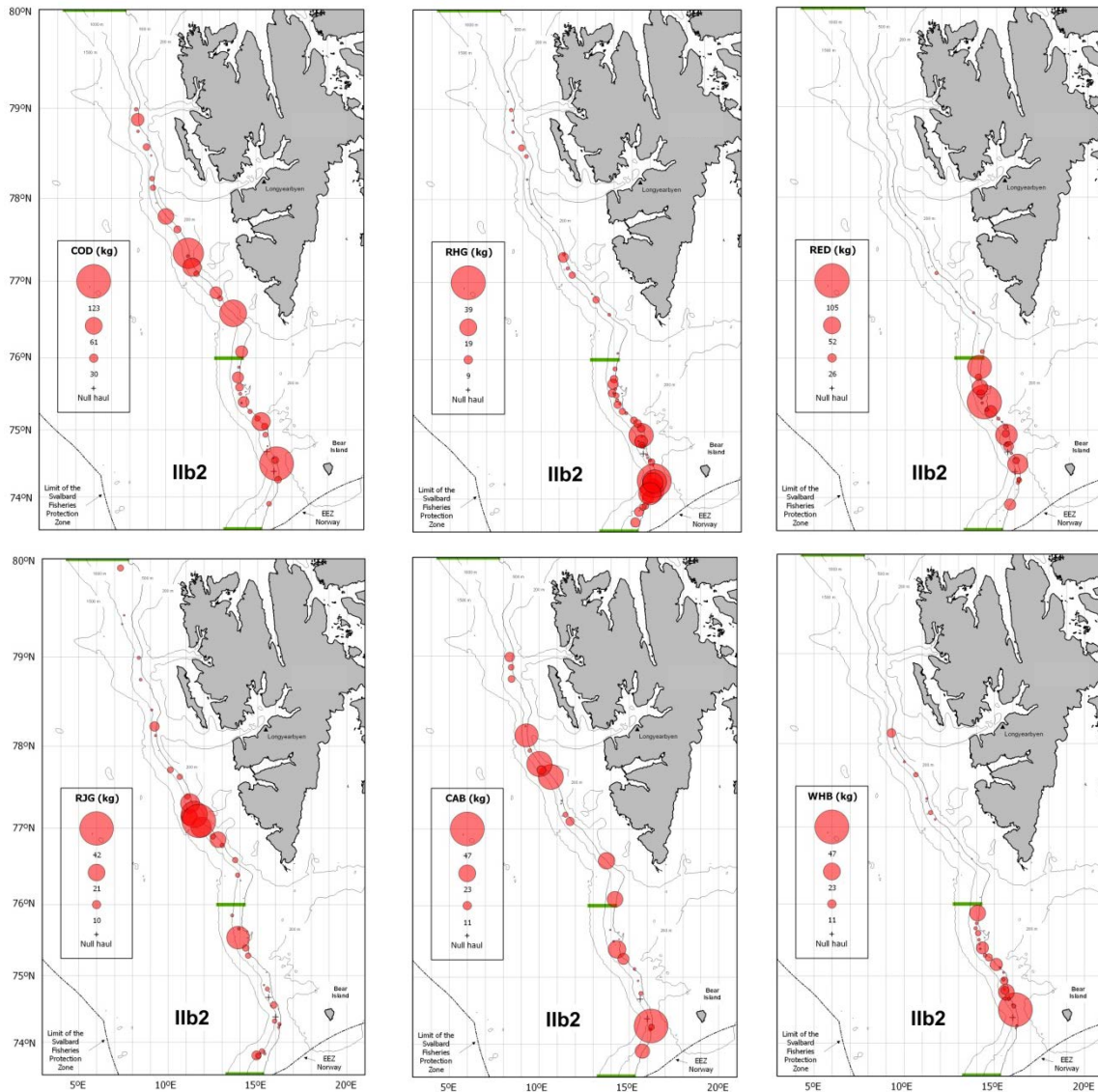


Figure 3.8.1 Maps of the study area showing the distribution of standardized weight (kg) per set (30 min hauls) of main by-catch species. COD: Cod; RHG: Roughhead grenadier; RED: Redfish; RJG: Arctic skate; CAB: Wolffish (*A. denticulatus*); WHB: Blue whiting. Spanish bottom trawl spring survey “FLETAN ÁRTICO 2015”.

3.9 Abundance and biomass of by-catch species

The estimated abundance and biomass indices for the principal by-catch species (Annex III) were very low when compared with the Greenland halibut indices, indicating that the Greenland halibut is clearly the dominant fish species on the slope of Svalbard.

3.10 Vulnerable Marine Ecosystems indicator species

In general, by-catch of Vulnerable Marine Ecosystems (VMEs) indicator species (sponges and cold-water corals) (FAO, 2009) was either absent or low. Only in two hauls the sea pen by-catches exceeded the NAFO threshold¹ for “significant research vessel trawl sea-pen catches” (haul No 18 = 2.42 kg; haul No 39 = 1.83 kg). Stony corals, cup corals, black corals and sea fans were not present in the by-catch. The presence of cauliflower corals (Nephthedeidae) was negligible (total by-catch < 0.2 kg). Sponges (Porifera) and sea pens (Umbellulidae) were the two main VME indicator species in the area. The distribution maps of both indicators are presented in Figure 3.10.1. Worth noting is the low presence of sponges and sea pen by-catches in most of the hauls carried out to the south of 76° N.

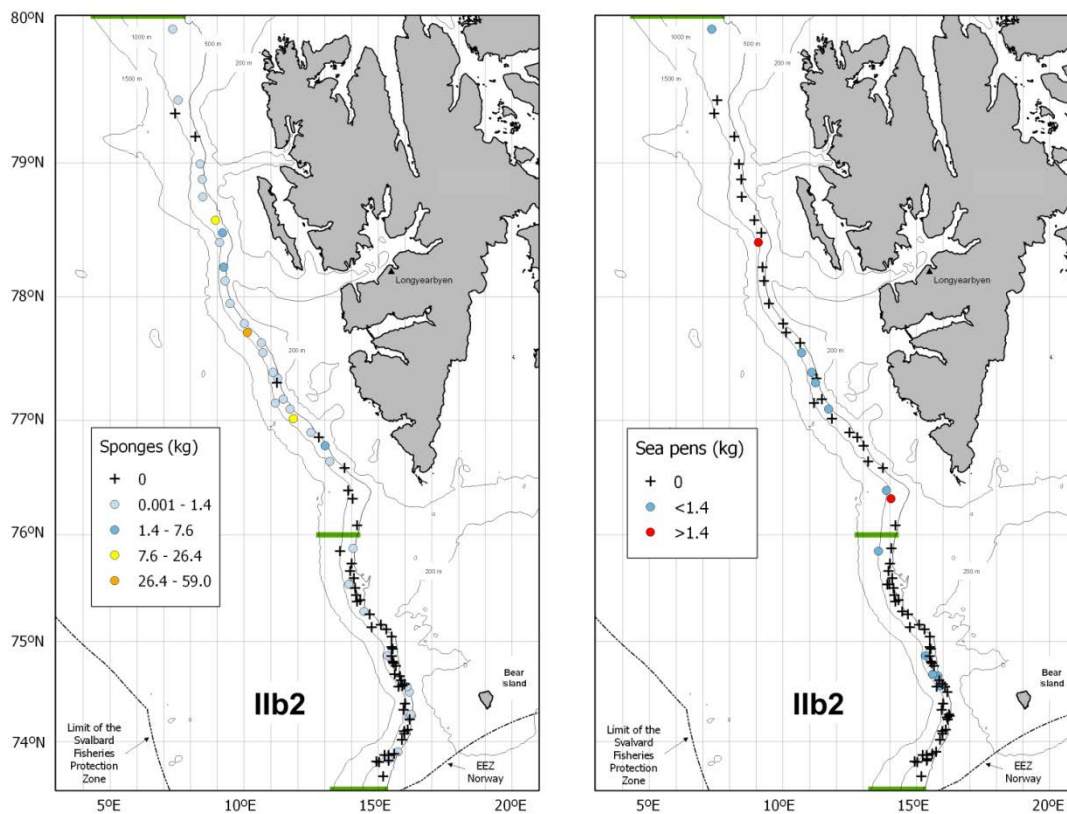


Figure 3.10.1 Distribution of the two main VME indicator species (sponges and sea pens) by haul (kg/30 minutes) in the study area. Black crosses represent absence of such indicators (by-catch = 0 kg). Spanish bottom trawl spring survey “*FLETAN ÁRTICO 2015*”.

¹ NAFO threshold for “significant research vessel trawl sea-pen catches” = 1.4 kg

4. Conclusions

The following main conclusions are derived from the results of the Spanish bottom trawl spring survey “FLETAN ÁRTICO 2015”:

1. Greenland halibut is clearly the predominant species on the slope of Svalbard (ICES Division IIB2) in June-July.
2. In line with other surveys conducted in the North-east Arctic, the Spanish spring surveys shows a positive trend in the abundance and biomass indices of the Greenland halibut, but these values are lower than the ones obtained from the autumn surveys.
3. Latitudinal and bathymetric distributions of Greenland halibut are similar to those observed in previous surveys: the main catches were recorded at depths between 600-750 m and the shallower strata of the south (4 and 5) show greatest concentrations of the species.
4. The structure of the Greenland halibut population is also quite similar to those described previously, with predominance of males. Modal length was 46 cm for males and 48 cm for females. Mature Greenland halibut individuals are dominant in the catches.
5. When compared with the Greenland halibut, the accompanying species show very low CPUE values and very low abundance and biomass indices.
6. By-catch of Vulnerable Marine Ecosystem (VMEs) indicator species was either absent or low. Only in two hauls the sea pen by-catches exceeded the NAFO threshold for “significant research vessel trawl sea-pen catches”.

5. Acknowledgements

We are grateful to the skipper and crew of the trawler for their cooperation during the survey and to the scientific staff onboard the vessel for the sampling work done during the cruise. Thanks are also due to the SGP for obtaining the scientific fishing authorisations, as well as to the staff of the IEO, the ship-owner and the association ARVI for assistance with the logistics of the survey. The survey was funded by the ship-owner under the IEO ECOPESLE project.

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ANNEXES

ANNEX I. Haul characteristics.

ANNEX II. Catches (kg in live weight) by haul of main fish species.

ANNEX III. Abundance ('000) and biomass (ton) by stratum for the main by-catch species.

ANNEX I. Haul characteristics. Spanish bottom trawl spring survey “*FLETAN ÁRTICO 2015*”.

Haul	Estrata	Valid	Date	Speed (kn)	Wire (m)	Hour start (UTC)	Hour end (UTC)	Lat start	Lat end	Lon start	Lon end	Depth start (m)	Depth end (m)	Doors opening (m)	Vertical opening (m)
1	6	Yes	20/06/2015	2.9	2,100	06:50	07:20	734760	734880	145610	145840	1,140	1,189	-	-
2	5	Yes	20/06/2015	2.8	1,543	09:22	09:52	734817	734940	152340	152562	744	736	-	-
3	5	Yes	20/06/2015	2.8	1,830	13:16	13:46	735157	735270	152325	152562	905	919	-	-
4	4	Yes	20/06/2015	2.8	1,200	15:31	16:01	735363	735472	154439	154709	619	583	-	-
5	4	Yes	22/06/2015	2.9	1,320	04:18	04:48	743021	743154	160964	160863	603	680	193	3.1
6	5	Yes	22/06/2015	2.9	1,470	06:32	06:58	743340	743436	160438	160182	705	700	208	3.0
7	5	Yes	22/06/2015	2.9	1,490	09:12	09:42	743494	743617	155896	155654	737	729	209	3.2
8	5	Yes	22/06/2015	2.8	1,680	13:53	14:23	743391	743507	155397	155104	855	853	245	2.7
9	4	Yes	23/06/2015	3.0	1,350	03:55	04:25	745575	745718	153241	153290	661	680	216	3.1
10	5	Yes	23/06/2015	3.0	1,460	05:52	06:22	745683	745831	153015	153087	721	741	218	2.7
11	4	Yes	23/06/2015	3.0	1,290	11:27	11:57	750288	750413	153030	152727	641	643	203	3.0
12	5	Yes	23/06/2015	3.1	1,860	14:21	14:51	750832	750926	144555	144093	925	941	250	2.9
13	4	Yes	23/06/2015	2.9	1,250	17:04	17:34	752383	752477	141996	141738	616	605	226	3.3
14	5	Yes	24/06/2015	2.9	1,480	03:57	04:27	752300	752439	141285	141024	739	741	236	2.7
15	5	Yes	24/06/2015	2.9	1,640	06:09	06:39	753264	753407	135466	135392	807	803	242	2.8
16	4	Yes	24/06/2015	2.9	1,260	08:29	08:59	754424	754568	140069	140012	618	623	227	2.9
17	1	Yes	24/06/2015	3.0	1,180	11:31	12:01	760515	760661	141305	141476	595	596	217	2.8
18	2	Yes	24/06/2015	3.1	1,860	14:06	14:36	761941	762082	140304	140456	934	933	244	2.9
19	3	Yes	25/06/2015	3.0	2,100	04:11	04:41	762377	762526	135296	135353	1,063	1,074	-	2.9
20	1	Yes	25/06/2015	2.9	1,220	06:36	07:06	763559	763651	134492	134007	593	588	-	3.1
21	2	Yes	25/06/2015	3.0	1,900	08:40	09:10	763898	764015	131172	130776	934	948	244	2.8
22	1	Yes	25/06/2015	3.0	1,340	11:36	12:06	764706	764840	130151	125850	675	659	227	2.9
23	1	Yes	25/06/2015	3.0	1,310	14:54	15:24	765142	765267	124747	124358	659	627	235	2.8
24	2	Yes	26/06/2015	3.1	1,680	04:06	04:36	765388	765516	122972	122593	852	825	249	2.3
25	2	Yes	26/06/2015	3.0	1,650	06:23	06:53	770089	770190	115030	114556	830	816	251	2.8
26	3	Yes	26/06/2015	3.0	2,100	08:50	09:20	770872	771003	111006	110769	1,052	1,050	252	2.8
27	1	Yes	26/06/2015	3.1	1,280	11:36	12:06	772093	772242	111541	111449	634	634	226	2.9
28	2	Yes	26/06/2015	3.0	1,680	13:50	14:20	772387	772535	110503	110405	841	821	249	2.6
29	1	Yes	26/06/2015	3.0	1,280	16:26	16:56	773818	773939	103895	103505	646	611	221	3.0
30	2	Yes	27/06/2015	2.9	1,450	08:41	09:11	795488	795348	72030	72288	716	727	223	2.9

ANNEX I (Cont.). Haul characteristics. Spanish bottom trawl spring survey “*FLETAN ÁRTICO 2015*”.

Haul	Estrata	Valid	Date	Speed (kn)	Wire (m)	Hour start (UTC)	Hour end (UTC)	Lat start	Lat end	Lon start	Lon end	Depth start (m)	Depth end (m)	Doors opening (m)	Vertical opening (m)
31	2	Yes	27/06/2015	3.0	1,740	12:34	13:04	792630	792488	73259	73399	868	861	221	2.8
32	3	Yes	27/06/2015	2.9	2,060	15:13	15:43	792082	791942	72582	72728	1,032	1,041	243	2.7
33	1	Yes	27/06/2015	2.9	1,340	18:27	18:57	791113	790980	81113	81381	660	657	-	2.7
34	2	Yes	28/06/2015	2.9	1,480	04:01	04:31	785947	785802	82163	82182	750	732	200	2.6
35	1	Yes	28/06/2015	2.8	1,250	06:11	06:41	785286	785152	82662	82770	605	604	217	2.8
36	2	Yes	28/06/2015	2.9	1,440	08:22	08:52	784523	784394	82780	83052	705	730	207	2.8
37	1	Yes	28/06/2015	3.1	1,330	11:32	12:02	783495	783363	85606	85976	661	673	219	2.7
38	2	Yes	28/06/2015	3.1	1,480	13:29	13:59	782930	782790	91181	91507	750	777	200	3.0
39	3	Yes	28/06/2015	2.8	2,020	15:42	16:12	782501	782365	90517	90647	1,002	1,050	239	2.8
40	2	Yes	29/06/2015	2.8	1,430	04:56	05:26	781373	781233	91448	91347	698	725	228	2.9
41	1	Yes	29/06/2015	2.9	1,270	08:13	08:43	780741	780597	91773	91795	627	661	200	2.8
42	1	Yes	29/06/2015	2.9	1,280	11:31	12:01	775686	775557	92876	93146	646	661	209	2.9
43	1	Yes	29/06/2015	2.9	1,190	13:53	14:23	774742	774630	100077	100536	594	601	225	3.0
44	2	Yes	30/06/2015	2.6	1,770	04:03	04:33	774314	774207	100732	101228	877	891	233	2.7
45	2	Yes	30/06/2015	3.2	1,910	06:36	07:06	773346	773210	104220	104529	948	959	230	2.8
46	2	Yes	30/06/2015	3.0	1,480	09:25	09:55	771879	771740	111357	111542	716	693	226	2.7
47	1	Yes	30/06/2015	2.9	1,320	11:55	12:25	771063	770943	112780	113122	666	648	230	2.6
48	1	Yes	30/06/2015	2.9	1,300	13:59	14:29	770565	770456	114293	114691	632	641	222	2.8
49	4	Yes	01/07/2015	2.9	1,200	03:52	04:22	755263	755118	140394	140367	584	586	213	2.8
50	6	Yes	01/07/2015	2.8	2,100	06:22	06:52	755111	754979	133480	133316	1,061	1,071	251	3.0
51	4	Yes	01/07/2015	3.0	1,410	08:58	09:28	754012	753872	135744	135862	691	691	217	2.8
52	4	Yes	01/07/2015	3.1	1,190	12:43	13:13	751574	751477	144114	144576	564	593	214	2.8
53	4	Yes	01/07/2015	3.1	1,230	14:44	15:14	750974	750867	150613	151019	591	604	229	2.9
54	4	Yes	02/07/2015	2.9	1,230	03:49	04:19	750708	750602	151834	152181	608	615	228	2.9
55	5	Yes	02/07/2015	2.9	1,460	06:28	06:58	745150	745007	153015	153083	703	710	210	2.9
56	4	Yes	02/07/2015	2.8	1,420	08:59	09:29	744830	744698	153276	153444	690	681	201	3.0
57	6	Yes	02/07/2015	2.9	2,190	13:26	13:56	741946	741809	155688	155664	1,073	1,165	241	2.9
58	5	Yes	03/07/2015	3.1	1,430	03:58	04:28	741360	741209	161052	160972	706	685	207	2.7
59	5	Yes	03/07/2015	2.9	1,600	06:05	06:35	740644	740536	155841	155495	787	809	223	2.9

ANNEX I (Cont.). Haul characteristics. Spanish bottom trawl spring survey “*FLETAN ÁRTICO 2015*”.

Haul	Estrata	Valid	Date	Speed (kn)	Wire (m)	Hour start (UTC)	Hour end (UTC)	Lat start	Lat end	Lon start	Lon end	Depth start (m)	Depth end (m)	Doors opening (m)	Vertical opening (m)
60	6	Yes	03/07/2015	2.9	2,150	11:39	12:09	734724	734584	150211	150041	1,084	1,057	-	-
61	4	Yes	03/07/2015	3.2	1,410	13:51	14:21	733824	733668	151127	151125	704	693	240	2.6
62	6	Yes	04/07/2015	3.1	2,160	04:10	04:40	735161	735280	151438	151796	1,091	1,078	255	3.0
63	5	Yes	04/07/2015	2.9	1,460	06:51	07:21	740112	740226	155322	155643	728	743	212	3.2
64	4	Yes	04/07/2015	2.9	1,370	09:14	09:44	740732	740866	160610	160814	678	649	223	2.7
65	4	Yes	04/07/2015	3.0	1,380	11:34	12:04	741669	741812	161334	161465	706	668	218	2.7
66*	6	No	05/07/2015	-	2,200	04:14	04:44	742324	742345	160006	160021	1,070	1,100	-	-
67	6	Yes	05/07/2015	2.9	1,980	06:35	07:05	743343	743453	154567	154256	1,023	1,014	258	2.8
68	5	Yes	05/07/2015	2.9	1,580	08:47	09:17	743719	743843	155133	154856	769	771	247	2.8
69*	5	No	05/07/2015	2.9	1,750	11:29	11:44	744083	744122	153705	153550	861	869	-	2.6
70	4	Yes	05/07/2015	3.1	1,200	13:19	13:49	744575	744723	153949	153739	611	613	-	2.8
71	5	Yes	05/07/2015	3.0	1,800	15:15	15:45	745173	745318	152123	151971	906	922	-	2.7
72	4	Yes	06/07/2015	3.1	1,410	03:58	04:28	751734	751864	142826	142543	675	679	240	2.6
73	4	Yes	06/07/2015	3.0	1,320	06:04	06:34	752664	752806	141059	140913	668	659	233	2.9
74	4	Yes	06/07/2015	3.0	1,280	08:01	08:31	753063	753210	140851	140799	622	613	226	2.8
75	5	Yes	06/07/2015	3.1	1,460	11:28	11:58	753269	753425	135903	135828	743	731	242	2.8
76	4	Yes	06/07/2015	3.1	1,200	13:22	13:52	753613	753766	140580	140660	603	567	220	2.9
77	4	Yes	07/07/2015	2.9	1,360	03:58	04:28	744736	744607	153457	153663	689	677	211	2.9
78	5	Yes	07/07/2015	2.9	1,450	06:10	06:40	743970	743857	154830	155166	720	706	214	2.8
79	4	Yes	07/07/2015	2.9	1,280	11:26	11:56	741575	741424	161454	161382	629	568	221	2.8
80	5	Yes	07/07/2015	3.0	1,490	13:30	14:00	741485	741355	160891	160597	728	781	225	2.7
81	5	Yes	08/07/2015	2.8	1,400	03:55	04:25	740493	740609	155882	160208	714	710	216	2.8
82	5	Yes	08/07/2015	2.7	1,380	07:29	07:59	735239	735326	153592	153850	709	694	216	2.8
83	5	Yes	08/07/2015	2.1	1,480	11:39	12:09	734917	734995	152403	152643	766	748	-	3.8

* Nule haul

ANNEX II. Catches (kg in live weight) by haul of main fish species. Spanish bottom trawl spring survey “*FLETAN ÁRTICO 2015*”.

Haul No	Greenland halibut	Cod	Redfish	Roughhead grenadier	Arctic skate	Wolffish (<i>A. denticulatus</i>)	Blue whiting	<i>Lycodes esmarkii</i>	Skate (<i>B. spinicauda</i>)
1	63.2	-	-	-	11.7	-	-	-	-
2	1,603.5	-	1.0	10.7	-	-	0.3	0.9	2.5
3	519.4	1.4	-	-	1.7	-	-	0.5	-
4	2,167.4	17.7	34.5	7.7	0.3	20.2	0.5	0.4	-
5	1,043.4	123.3	62.0	1.6	0.8	-	47.6	1.6	-
6	1,019.6	25.8	20.4	7.7	-	-	5.7	2.2	0.2
7	3,145.9	3.9	1.7	3.4	-	-	1.8	0.4	-
8	1,498.1	-	-	-	8.4	-	0.1	1.1	-
9	1,919.4	19.2	66.7	2.2	-	-	10.9	1.2	-
10	8,550.6	-	22.0	28.0	-	2.5	4.5	7.6	1.0
11	1,593.3	24.1	14.7	8.8	1.0	-	3.2	2.2	9.2
12	209.9	-	2.1	-	0.5	-	0.7	0.1	-
13	1,271.2	39.4	105.2	3.1	8.3	24.6	17.1	1.7	-
14	2,507.0	6.2	7.5	8.6	-	-	2.6	3.7	-
15	574.5	-	-	9.1	29.0	-	-	1.9	-
16	1,496.7	40.9	20.9	8.8	-	-	3.9	-	-
17	377.2	44.2	12.5	2.3	0.7	22.0	0.9	1.8	10.3
18	58.2	-	1.9	-	1.2	-	-	-	-
19	29.4	-	-	-	5.7	-	-	-	-
20	591.7	98.0	7.3	3.5	7.1	23.2	1.6	2.6	-
21	155.7	-	0.2	-	-	-	-	0.2	-
22	2,385.8	19.4	1.9	7.8	5.8	-	0.5	3.5	3.0
23	1,341.5	44.1	4.9	1.3	20.1	-	1.0	2.8	-
24	526.7	-	0.4	-	6.7	-	-	1.5	-
25	110.8	-	-	-	25.8	-	-	-	3.5
26	17.9	-	-	-	20.8	-	-	-	-
27	533.5	110.5	2.6	3.6	1.0	2.4	3.3	2.5	-
28	203.7	-	0.6	0.2	7.0	-	-	-	-
29	544.9	26.4	3.7	0.8	7.1	34.9	6.7	2.8	-
30	124.3	-	-	-	7.9	-	-	-	1.3
31	127.9	-	-	-	2.4	-	-	0.4	-
32	148.6	-	-	-	1.9	-	-	-	-
33	163.5	-	-	2.0	-	-	0.2	0.2	-
34	2,041.9	13.2	-	4.2	4.2	13.4	--	-	-
35	237.9	46.1	2.7	2.0	-	8.1	1.4	0.1	-
36	1,730.0	10.0	-	3.0	3.7	9.6	0.1	0.8	-
37	1,915.0	24.6	-	7.4	-	-	0.7	1.1	-
38	2,137.5	5.6	-	4.5	-	-	-	-	-
39	84.0	-	-	-	2.9	-	-	0.2	-
40	1,782.3	17.5	-	2.2	12.2	2.2	-	0.1	-
41	2,406.0	20.3	2.0	0.4	3.0	32.4	12.4	2.3	-
42	192.6	3.5	0.7	1.6	0.6	5.2	2.2	0.6	-
43	111.0	57.7	3.7	1.2	-	35.3	3.3	0.5	-
44	101.0	-	-	-	7.7	12.6	-	0.7	-
45	23.5	-	-	-	-	-	-	-	-

ANNEX II (Cont.). Catches (kg in live weight) by haul of main fish species. Spanish bottom trawl spring survey “FLETAN ÁRTICO 2015”.

Haul No	Greenland halibut	Cod	Redfish	Roughhead grenadier	Arctic skate	Wolffish (<i>A. denticulatus</i>)	Blue whiting	<i>Lycodes esmarkii</i>	Skate (<i>B. spinicauda</i>)
46	3,212.7	10.7	-	11.5	24.4	1.6	1.3	2.8	-
47	1,538.7	66.8	2.1	3.8	33.5	7.1	6.1	4.7	0.5
48	695.2	20.2	10.6	7.6	42.7	11.8	2.8	2.6	-
49	2,106.7	9.0	73.5	4.8	-	-	22.5	5.3	-
50	79.3	-	-	-	4.0	-	-	0.2	-
51	1,573.4	-	0.9	11.9	3.5	2.3	5.0	3.0	5.6
52	1,288.6	16.1	37.0	3.7	-	15.6	10.3	1.6	8.6
53	552.7	19.9	10.2	8.1	-	-	17.4	0.6	-
54	1,764.7	66.2	4.1	8.9	-	4.0	2.7	1.5	7.0
55	3,784.7	-	-	14.8	-	-	0.6	4.6	-
56	4,432.1	-	3.5	7.1	5.4	-	3.6	4.8	-
57	931.2	-	-	5.4	5.8	-	-	0.3	-
58	2,805.7	-	11.1	13.1	3.0	4.7	2.1	0.6	-
59	872.0	-	-	2.3	-	-	-	1.4	-
60	487.3	-	-	-	7.1	-	-	1.0	-
61	553.1	-	1.6	11.1	-	-	-	2.4	-
62	338.5	-	-	-	6.3	-	-	2.8	-
63	789.2	-	-	13.4	-	-	-	0.5	0.5
64	2,799.0	-	1.7	27.0	-	-	0.2	1.4	0.5
65	2,697.5	-	13.0	39.2	4.3	47.2	0.7	0.4	2.4
66*	46.4	-	-	-	-	-	-	-	-
67	448.8	-	-	-	0.8	-	-	-	2.7
68	1,707.1	-	-	2.5	0.5	-	-	2.2	-
69*	122.6	-	-	-	6.6	-	-	-	-
70	1,785.1	4.4	30.7	2.2	1.2	5.8	22.4	5.6	7.8
71	416.2	-	0.6	1.4	2.1	-	0.2	0.2	11.7
72	2,570.7	-	11.6	7.4	7.1	-	5.0	1.3	-
73	3,036.8	-	5.1	3.7	-	-	1.5	2.2	-
74	2,317.6	11.2	25.6	6.3	-	2.6	4.1	0.5	-
75	1,336.3	-	2.9	2.3	-	-	0.3	0.9	-
76	1,171.8	28.7	47.5	3.0	-	-	7.8	1.3	-
77	4,280.3	-	13.9	4.0	-	-	11.6	3.9	-
78	3,673.8	-	7.2	2.4	-	-	4.5	0.7	-
79	2,398.5	24.7	15.1	27.8	2.2	8.0	3.4	-	-
80	1,243.8	-	0.8	22.9	-	-	-	0.3	0.4
81	1,079.5	-	-	25.8	-	-	-	1.5	5.0
82	1,079.0	-	0.8	7.5	-	-	-	1.7	-
83	191.0	-	-	0.8	3.2	-	-	0.8	-

*Nule haul

ANNEX III. Abundance ('000) and biomass (ton) by stratum for the main by-catch species. Spanish bottom trawl spring survey “*FLETAN ÁRTICO 2015*”.

Table A. Cod.

Estrata	Area (nm ²)	No of hauls	Catch (number)	Catch (kg)	Swept area (nm ²)	Abundance ('000)	Biomass (ton)
1	702	14	131	581.6	0.468	196	872
2	1,263	14	10	57.0	0.472	27	152
3	2,693	4	-	-	0.133	-	-
4	488	22	85	444.8	0.743	56	292
5	761	21	8	37.3	0.685	9	41
6	1,672	6	-	-	0.198	-	-
Total	7,579	81	234	1,120.6	2.699	288	1,358

Table B. Roughead grenadier.

Estrata	Area (nm ²)	No of hauls	Catch (number)	Catch (kg)	Swept area (nm ²)	Abundance ('000)	Biomass (ton)
1	702	14	114	45.0	0.468	171	67
2	1,263	14	35	25.5	0.472	94	68
3	2,693	4	-	-	0.133	-	-
4	488	22	258	208.3	0.743	170	137
5	761	21	167	176.7	0.685	186	196
6	1,672	6	3	5.4	0.198	25	45
Total	7,579	81	577	460.8	2.699	645	514

Table C. Redfish.

Estrata	Area (nm ²)	No of hauls	Catch (number)	Catch (kg)	Swept area (nm ²)	Abundance ('000)	Biomass (ton)
1	702	14	116	54.6	0.468	174	82
2	1,263	14	9	3.2	0.472	24	8
3	2,693	4	-	-	0.133	-	-
4	488	22	911	598.9	0.743	599	394
5	761	21	143	78.1	0.685	159	87
6	1,672	6	-	-	0.198	-	-
Total	7,579	81	1,179	734.7	2.699	955	571

ANNEX III. (Cont.). Abundance ('000) and biomass (ton) by stratum for the main by-catch species. Spanish bottom trawl spring survey “FLETAN ÁRTICO 2015”.

Table D. Arctic skate.

Estrata	Area (nm ²)	No of hauls	Catch (number)	Catch (kg)	Swept area (nm ²)	Abundance ('000)	Biomass (ton)
1	702	14	41	121.5	0.468	61	182
2	1,263	14	43	103.1	0.472	115	276
3	2,693	4	17	31.3	0.133	345	634
4	488	22	13	34.1	0.743	9	22
5	761	21	17	48.4	0.685	19	54
6	1,672	6	25	35.7	0.198	211	300
Total	7,579	81	156	374.0	2.699	760	1,469

Table E. Woffish (*A. denticulatus*).

Estrata	Area (nm ²)	No of hauls	Catch (number)	Catch (kg)	Swept area (nm ²)	Abundance ('000)	Biomass (ton)
1	702	14	31	182.4	0.468	47	273
2	1,263	14	7	39.4	0.472	19	105
3	2,693	4	-	-	0.133	-	-
4	488	22	18	130.4	0.743	12	86
5	761	21	3	7.2	0.685	3	8
6	1,672	6	-	-	0.198	-	-
Total	7,579	81	59	359.3	2.699	81	472

Table F. Blue whiting.

Estrata	Area (nm ²)	No of hauls	Catch (number)	Catch (kg)	Swept area (nm ²)	Abundance ('000)	Biomass (ton)
1	702	14	169	43.1	0.468	253	65
2	1,263	14	6	1.5	0.472	16	4
3	2,693	4	-	-	0.133	-	-
4	488	22	807	201.2	0.743	530	132
5	761	21	127	23.5	0.685	141	26
6	1,672	6	-	-	0.198	-	-
Total	7,579	81	1,109	269.2	2.699	941	227